

 Open Access

Article Information

Received: February 4, 2026

Accepted: February 15, 2026

Published: February 24, 2026

Authors' Contribution

All authors conceived and designed the study; wrote and revised the paper.

Citation

AlMa'aitah, Y.I.J., Al Momani, R.M.A., Almomani, A.A.R., Al Masri, N.R.A.R., Raqqad, S.K.S 2026. An Examination of Rocuronium Bromide and Sugammadex Vial Distribution and Consumption Patterns Across Key Hospitals in the Jordanian Royal Medical Services. *Int. J. Nanotechnol. Allied Sci.*, 10(1): 15-24.

***Correspondence**

Yasmeen Ibrahim Jwai'd AlMa'aitah
Email: ymaaita.ph.25@gmail.com

Possible submissions

 [Submit your article](#)

An Examination of Rocuronium Bromide and Sugammadex Vial Distribution and Consumption Patterns Across Key Hospitals in the Jordanian Royal Medical Services

Yasmeen Ibrahim Jwai'd AlMa'aitah^{1*}, Rawan Mazen Ali Al Momani¹, Afnan Adnan Radi Almomani¹, Nizar Rida Abdel Razzaq Al Masri¹, Shahed Khaled Soud Raqqad¹

¹Royal Medical Services, Jordan.

Abstract:

The effective management of important pharmaceuticals is one of the main factors in maintaining operational preparedness and care quality of the national health care systems. The primary objective of this study was to compare the distribution patterns of rocuronium bromide and Sugammadex in three major hospitals of JRMS over four years, from 2020 to 2023, in a quantitative manner. This paper presents a quantitative, retrospective study of pharmaceutical distribution data. The source of data is the average monthly amount of distributed quantities of Rocuronium bromide vials and Sugammadex vials of the three identified JRMS hospitals obtained from the JRMS record. The analysis revealed marked variability in the distribution and consumption patterns of Rocuronium bromide and Sugammadex across the three JRMS hospitals during the 2020–2023 period. Overall, Rocuronium distribution peaked in 2020, followed by a substantial decline in 2021, reflecting the acute impact of the COVID-19 pandemic on intensive care utilization and elective surgical activity, before stabilizing in 2022–2023. In contrast, Sugammadex distribution demonstrated a generally increasing and more stable trend throughout the study period, indicating progressive adoption of modern neuromuscular blockade reversal practices. Hospital-level analysis showed heterogeneous trends, with King Hussein Medical Centre exhibiting a significant increase in Sugammadex utilization and a declining Rocuronium-to-Sugammadex ratio, while the Royal Rehabilitation Centre maintained a consistently high ratio suggestive of limited uptake. Prince Rashid Ben Al-Hasan Military Hospital displayed the lowest average ratio overall, reflecting relatively greater reliance on Sugammadex despite recent cost-containment tendencies. These findings support the need for harmonized clinical guidelines, informed forecasting that accounts for pandemic-related outliers, and strategic investment in Sugammadex to balance patient safety with financial sustainability across the JRMS network.

Keywords: Rocuronium bromide, Sugammadex, hospital, patient safety, Jordanian Royal Medical Services.



Scan QR code to visit this journal.

©2026 PSM Journals. This work at International Journal of Nanotechnology and Allied Sciences; ISSN (Online): 2523-9252, is an open-access article distributed under the terms and conditions of the Creative Commons Attribution-Non-commercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0) licence. To view a copy of this licence, visit <https://creativecommons.org/licenses/by-nc-nd/4.0/>.

INTRODUCTION

Reliable and fair distribution of essential drugs is a cornerstone of any good healthcare system in any country. In the Hashemite Kingdom of Jordan, the Jordanian Royal Medical Services (JRMS) is a major provider of health care, particularly among the military personnel and their dependents, via a network of specialized hospitals and medical centers (JRMS, 2025). The JRMS supply chain efficiency, which is managed through its main medical warehouses, has a direct impact on patient safety and clinical outcomes in the tertiary care facilities of the JRMS supply chain. This paper discusses two important agents used in the field of anesthesiology: Rocuronium bromide vials, which are a non-depolarizing neuromuscular blocking agent (NMBA), and Sugammadex vials, which are the respective selective reversal agent (Kim *et al.*, 2021).

Rocuronium bromide is commonly used to support tracheal intubation and skeletal muscle relaxation in surgery, especially in rapid sequence induction (RSI) situations (Abu-Halaweh *et al.*, 2007). Due to this efficacy, which is enhanced by the presence of a quick and special reversal agent, it has established as a norm in the current anesthetic practice. Sugammadex is a modified gamma cyclodextrin that has a quick and full reversal action of rocuronium-induced neuromuscular blockade (NMB) (Abad-Gurumeta *et al.*, 2015). The utilization and supply trends of these two agents are inherently connected, and the ratio of consumption of Rocuronium to Sugammadex could function as one of the primary indicators of medical practice, resource utilization, and adherence to the modern NMB monitoring and reversal recommendations (Brull and Murphy, 2010).

The time interval being considered (2020-23) is especially notable because it will include the most active years of the worldwide COVID-19 crisis. This period presented the world with new demands on the global pharmaceutical supply chains, logistics, and resource allocation in

hospitals never seen before (Nassar *et al.*, 2023; Soetikno *et al.*, 2024). Moreover, the COVID-19 pandemic prompted dramatic changes in the number of surgical cases and NMBAs usage in the intensive care departments (ICUs) to serve patients with mechanical ventilation, which might change the consumption patterns within tertiary care hospitals (Baccolini *et al.*, 2021). The rapid evolution of SARS-CoV-2 variants has led to widespread immune evasion. Understanding immune memory to SARS-CoV-2 is critical for improving diagnostics and vaccines (Iqbal, 2021a; Iqbal, 2021b; Iqbal *et al.*, 2021).

This paper analyses the distribution data of Sugammadex vials and Rocuronium bromide in three major JRMS hospitals, namely, King Hussein Medical Centre (KHMC), the Royal Rehabilitation Centre (RRC), and Prince Rashid Ben Al-Hasan Military Hospital (PRBMH), from the JRMS main medical warehouses. The research intends to determine: (1) the amount and pattern of the distribution quantities of these critical drugs at all three hospital settings during the four years; (2) probably, identify some correlations between the distribution pattern and known extraneous factors, including the COVID-19 pandemic; and (3) infer the clinical preferences and resource management strategies based on the computation and calculation of the Rocuronium-to-Sugammadex consumption ratio, in each of the three hospital environments. The results will give useful information on the logistic and clinical dynamics of pharmaceutical distribution in a large military healthcare system in the Middle East.

LITERATURE REVIEW

Neuromuscular Blocking Agents and Reversal

The field of neuromuscular blocking agents (NMBAs) has developed enormously since the inception of curare. Rocuronium bromide is one of the aminosteroid NMBAs that is preferable for the intermediate-acting, prerequisite to fast and dependable intubation, which is essential in

emergencies (Abu-Halaweh *et al.*, 2007; Szewczyk *et al.*, 2025). It competitively attaches itself to nicotinic acetylcholine receptors located at the neuromuscular junction, which leads to muscle paralysis. However, the severity and duration of this blockade require it to be monitored and handled carefully (Palsen *et al.*, 2019).

The major clinical complication of NMBAs is the presence of residual neuromuscular blockage (RNMB), which is characterized by a train-of-four (TOF) ratio that is below 0.9. It is a frequent and severe complication of RNMB, which strikes up to 40 percent of cases of a patient in case of improper reversal, causing dyspnea, aspiration, and elevated morbidity (Brull and Murphy, 2010). This threat sets the international trend for compulsory quantitative monitoring and applicable yet effective reversal strategies.

The standard reversal agent in use before Sugammadex was the acetylcholinesterase inhibitor neostigmine. Neostigmine is slow, shallow-acting only, and has muscarinic side effects (Naguib and Brull, 2009). The most advantageous breakthrough of reversal agents was Sugammadex, a selective relaxant binding agent (SRBA), which directly encapsulated rocuronium (Abad-Gurumeta *et al.*, 2015). This mechanism is fast, predictable, and efficient even at deep NMB, which greatly decreases RNMB (Krijtenburg *et al.*, 2024; Naguib and Brull, 2009). The cost of Sugammadex can still be seen as a barrier, even though its clinical superiority can be quite significant, making the ratio of the consumption of Rocuronium to Sugammadex an important indicator of the measure of investment regarding the advanced safety measures implemented at a certain hospital (Krijtenburg *et al.*, 2024).

Pharmaceutical Supply Chain and Distribution in Military Healthcare Systems

Jordanian Royal Medical Services (JRMS) is a state-funded healthcare provider that is centralized and serves mainly the army. The RMS Medical Supply Directorate is an organization with an elaborate logistics

operation, involving the distribution of pharmaceuticals from a central warehouse to a system of tertiary hospitals (JRMS, 2025). This model of distribution presupposes advanced forecasting and inventory management that is complicated by the geopolitical factors of the region and the necessity to be operationally prepared (Tamimi *et al.*, 2024). The data are indicative of a centrally controlled methodology of allocation, which is a blend of push and pull systems.

The effectiveness of the pharmaceutical supply chain in Jordan is an issue that has received continuous research interest with regard to the shortage of drugs. Complications in the processes of regulation, delays in the procurement process, and a lack of proper inventory control systems are some of the factors that have led to shortages (Awad *et al.*, 2016). The JRMS also has a military structure, which is less likely to have a disrupted and less effective supply chain than the civilian sector of the Ministry of Health (MOH), but it is not immune to global supply disruptions. These external factors are especially sensitive to the distribution of high-value, critical-care drugs like Sugammadex (which is often imported). The consistency in Sugammadex distribution, even though the Rocuronium is volatile, may be an indicator of a successful manner in which the JRMS has attempted to procure things that are considered vital but extremely expensive through the adoption of a ring-fenced procurement process.

Hospital Specialization and Consumption Patterns

The three hospitals chosen in this study cannot be interchangeable; they have divergent clinical missions, which are the basis of and shape their need for neuromuscular blocking (NMBAs) and reversal agents:

King Hussein Medical Hospital (KHMC): KHMC is the biggest tertiary-level hospital and therefore handles the largest number and complexity of cases, which include trauma cases, cardiac, neurosurgical, and many others. As a result, it

has an extensive use of Rocuronium. At the same time, in the role of a teaching institution, it is expected to note an increase in the Sugammadex usage, though its moderate Roc:Sug ratio reflects a balance between best practice and cost-effectiveness.

Royal Rehabilitation Centre (RRC): RRC deals with rehabilitation and elective processes and has a history of consistently low and non-varying Rocuronium volume. The high ratio of Roc:Sug observed is a critical finding indicating preference towards traditional reversal or spontaneous recovery, perhaps because of a healthier patient population and simplified surgical procedures. This practice should be questioned in an attempt to have uniform norms of reversal of neuromuscular blockade (Brull and Murphy, 2010).

Prince Rashid Ben Al-Hasan Military Hospital (PRBMH): Being a large regional hospital with a wide case mix, the utilization of Rocuronium in PRBMH is moderate. The most interesting result is the low average Roc:Sug ratio, which is interpreted as an indication of an aggressive local protocol toward Sugammadex utilization, challenging the theory that the largest hospital (KHMC) would be the best at advanced NMB reversal practices.

The Impact of the 2020-2023 Period

The time under analysis is closely related to the worldwide health crisis of the COVID-19 pandemic. The transient burst of Rocuronium dispersion in 2020 is a distinct indicator of the epidemic effect on critical care, wherein NMBAs played a critical role in mechanical ventilation of acute COVID-19 cases (Baccolini *et al.*, 2021). The decrease in the distribution of Rocuronium in 2021 was followed by stabilization and reflects the curve of the epidemiological situation and the development of clinical treatment of COVID-19.

The steady growth of Sugammadex distribution, especially at KHMC, over the course of this period can be explained through the shift towards the focus on patient safety. The

increased awareness about respiratory complications in the conditions of the pandemic might have increased the awareness of the risks of residual neuromuscular blockade and, in turn, the institutional responsibility towards the use of the safest possible reversal agent. Therefore, these 2020-2023 data represent a rare longitudinal view of how a large pharmaceutical healthcare system had to adapt its pharmaceutical logistics and clinical practice to a major global health crisis, never seen before.

MATERIALS AND METHODS

Study Design and Data Source

This paper utilizes a retrospective and quantitative design analysis of drug distribution records. The data to be used as the source was monthly average volumes of vials of Rocuronium Bromide and vials of Sugammadex distributed to three selected hospitals (King Hussein Medical Hospital, Royal Rehabilitation Centre, and Prince Rashid Ben Al-Hasan Military Hospital) over four years (2020-2023) by the JRMS main medical warehouses. The data are assumed to reflect what is actually consumed or demanded by the hospitals, accounting for periods of possible stock outages at the hospital level by reflecting the central distribution decision. The use of the average quantities every month averages out the short-term variations and gives a more reliable result regarding the long-term demand and distribution trends throughout the year.

Data Variables and Preparation

The dataset consists of four primary variables: (1) Year: The calendar year (2020, 2021, 2022, and 2023). (2) Medication Name: Rocuronium Bromide Vial or Sugammadex Vial. (3) Hospital: The three specified JRMS hospitals. (4) Average Monthly Quantity (AMQ): The average amount of vials that are distributed within a month that year. Considering the raw data, they were initially converted from the original cross-tabular format to a long-format dataset, and the Pandas

library of Python was used to convert them. This change allowed us to calculate derived metrics and apply group-by operations to make comparative analysis.

Data Analysis and Metrics

The Python (Pandas and Matplotlib libraries) were used in analysis, and the following key metrics and visualizations were considered: (1) Total Annual Distribution Trend: The AMQ was multiplied by 12 in order to estimate the annual distribution of each drug. Such a measure was graphically presented to demonstrate the trend of all medication use at the JRMS network sample. (2) Hospital-Specific Consumption Trends: The AMQs of each drug were displayed individually in each hospital. The given granular analysis made it possible to identify hospital-specific anomalies. (3) Rocuronium to Sugammadex ratio (Roc:Sug Ratio): Calculated by dividing the AMQ of Rocuronium Bromide by the AMQ of Sugammadex for each hospital in a year. (Roc:Sug Ratio = AMQ of Rocuronium Bromide/AMQ of Sugammadex), this ratio is the key analysis tool that can be used to make conclusive clinical preference and resource distribution assumptions. A smaller ratio suggests that a larger portion of the particular reversal agent was utilized, which implies more compliance with the modern NMB monitoring and reversal guidelines (Krijtenburg *et al.*, 2024). (4) Hospital distribution Share: The percent share of individual hospitals in the total combined annual distribution of both drugs was

determined during the first (2020) and the last (2023) year of the study to determine changes in relative significance or activity of the hospitals within the network. (5) Percentage Change Analysis: Percentage change in AMQ between the two medications was determined in the period between 2020 and 2023 for each hospital to measure the extent and degree of change during the period of study.

RESULTS AND DISCUSSION

Overall Distribution Trends

The macro-level analysis of the overall estimated annual allocation of both Rocuronium Bromide and Sugammadex in the three hospitals shows an evolving, intricate picture of drug demands throughout the research time (2020-2023) (Table 1).

The most noteworthy finding was the 49.2 percent drop in Rocuronium Bromide distribution from 2020 to 2021. This significant drop indicates an excessive weight of influence of the first wave of COVID-19, when neuromuscular blocking agents (NMBAs) were largely used in intensive care units in managing severe acute respiratory syndrome (Baccolini *et al.*, 2021). At the same period, there was a 47.7 percent decline in the aggregate combined distribution, reflecting an indication of the delay of elective surgical operations.

Table 1. Estimated Total Annual Distribution of Rocuronium Bromide and Sugammadex (2020-2023).

Year	Rocuronium Bromide (Vials)	Sugammadex (Vials)	Total Combined (Vials)
2020	48,588	1,020	49,608
2021	24,660	1,272	25,932
2022	33,180	1,224	34,404
2023	35,604	1,284	36,888

On the other hand, the growth in the distribution of Sugammadex had a 24.7 percent rise in the period between 2020 and 2021 and is comparatively steady thereafter. This post-hoc is critical: the demand for Rocuronium was

fluctuating and pandemic-driven, but Sugammadex demonstrated a consistently positive growth pattern, indicating adoption and promotion by a growing number of healthcare providers interested in choosing clinical wellness

and their commitment to reducing RNMB (Krijtenburg *et al.*, 2024). Further stabilization of Rocuronium in 2022-2023, with continuing volumes of Sugammadex, is an indicator of return to a new, higher level of neuromuscular blockade reversal practice.

Hospital-Specific Consumption and Change Analysis

The aggregated data cover up major heterogeneity at the individual hospital level. Table 2 summarizes the variations in the mean monthly distribution for each hospital.

King Hussein Medical Hospital (KHMC)

The evidence of KHMC shows not only the impact of the pandemic but also a significant change in clinical practice. The -30.11% change

in Rocuronium distribution supports that the 2020 figures were inflated, which can be explained by a transient surge in ICU. The corresponding +39.66% change in the use of Sugammadex is significant, implying that the change in institutional policy with regard to routinely using Sugammadex as the preferred neuromuscular blockade reversal agent is striking. This is in line with the requirement of the hospital compared to being a leading tertiary center where best-practice protocols should be promoted (Almomani, 2024). The average Roc:Sug ratio of 28.73, 50.5 in the year 2020, is a clear indication of the success in the movement towards safer management of neuromuscular blockade.

Table 2. Summary of Distribution Changes and Average Roc:Sug Ratio (2020 vs. 2023).

Hospital	Roc 2020 (Avg Monthly)	Roc 2023 (Avg Monthly)	Roc Change (%)	Sug 2020 (Avg Monthly)	Sug 2023 (Avg Monthly)	Sug Change (%)	Avg Roc:Sug Ratio (2020-2023)
King Hussein Medical Hospital	2,929	2,047	-30.11%	58	81	+39.66%	28.73
Royal Rehabilitation Centre	201	201	0.00%	9	10	+11.11%	48.18
Prince Rashid Ben Al-Hasan Military Hospital	919	719	-21.76%	18	16	-11.11%	19.19

Royal Rehabilitation Centre (RRC)

RRC profile is defined by stability; the percentage of Rocuronium use did not change (0.00%), therefore acting as a control value in the specialized, non-acute consumption. The relative tranquility of the +11.11 percent growth in Sugammadex denotes a slow integration of the agent. However, the RRC average Roc:Sug ratio of 48.18 is a high indicator of still utilizing traditional reversal agents, which indicates a concern about sustained RNMB vulnerability. This practice, based on resources, is not considered the network pattern, and it is

important to reconsider the reversal protocol and reduce residual neuromuscular blockade.

Prince Rashid Ben Al-Hasan Military Hospital (PRBMH)

PRBMH is a multifactorial presentation. The normalization by post-pandemic is reflected in the -21.76 percent reduction of Rocuronium. More importantly, PRBMH is the only facility that has shown a -11.11 % fall in the utilization of Sugammadex distribution, going against the trend of the network. Even so, the hospital has the lowest average of Roc:Sug ratio of 19.19,

which means that it has a larger commitment to Sugammadex in relative terms. Nevertheless, the low ratio is concentrated in the increased degree of temporary usage in the period 2021-2022, and then followed by a deviation towards the more conservative and cost-oriented practices in 2023 (ratio increases to 44.9).

Rocuronium-to-Sugammadex Ratio: A Proxy for Clinical Preference

Roc:Sug ratio is a powerful tool that indicates the clinical practice pattern and the distribution

of resources. The wide gap in the mean ratios (19.19 at PRBMH and 48.18 at RRC) indicates that the JRMS network has no single, unified protocol of reversing neuromuscular blockade. The statistics and data firmly point the finger at the issue of costs as the main influence of perceived changes. Even when the clinical superiority of Sugammadex cannot be disputed, its high cost does put pressure on hospitals to make decisions to balance between optimal patient safety and financial sustainability.

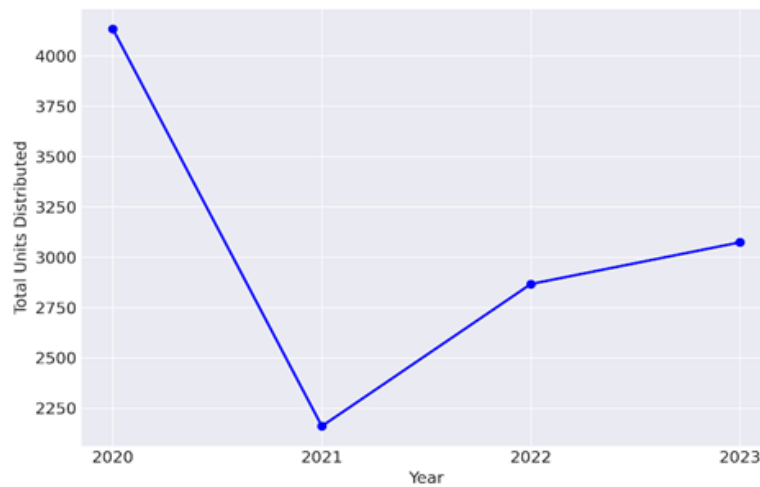


Fig. 1. Total annual distribution trend (2020-2023).

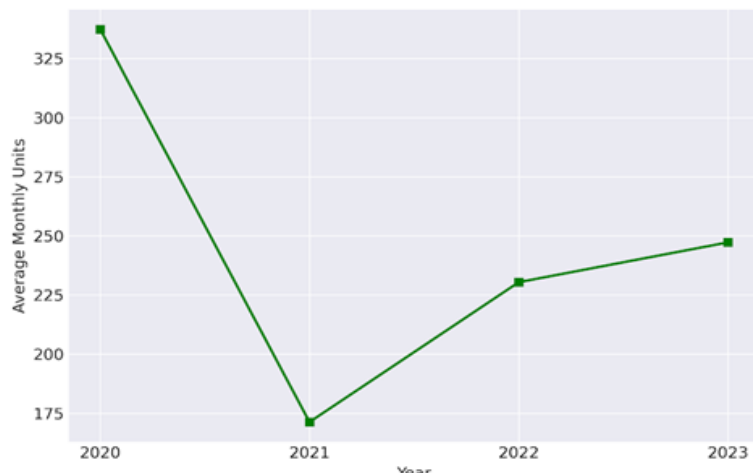


Fig. 2. Average monthly distribution trend for Rocuronium bromide vial (2020-2023).

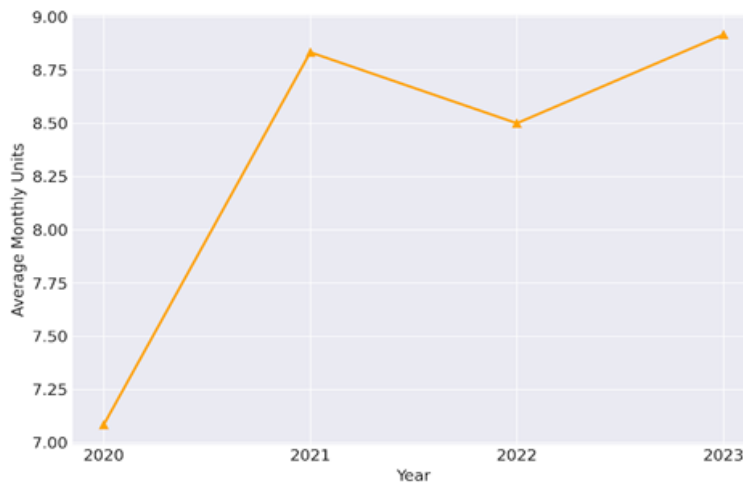


Fig. 3. Average monthly distribution trend for Sugammadex vial (2020-2023).

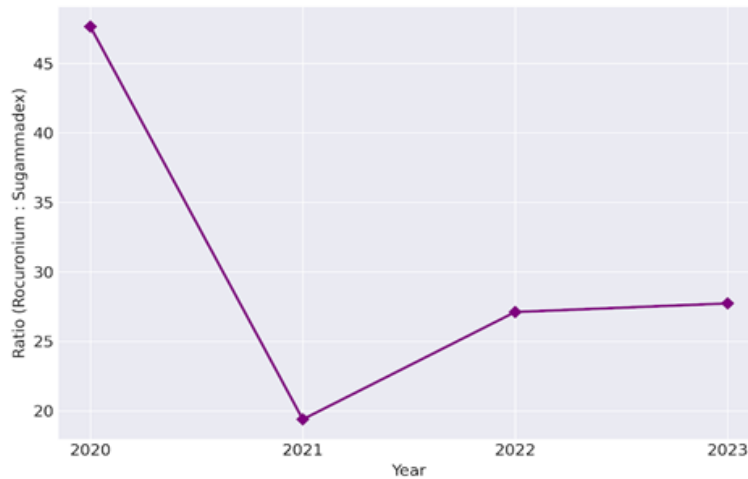


Fig. 4. Rocuronium to Sugammadex distribution ratio (2020-2023).

Hospital Distribution Share Dynamics

The distribution shares of the hospitals based on the sum of the respective combined distribution

of both medications provide a macro-level point of view of the relative scale of operations of each center (Table 3).

Table 3. Hospital Share of Total Combined Distribution (2020 vs. 2023).

Hospital	Share in 2020	Share in 2023	Change in Share (2020 to 2023)
King Hussein Medical Hospital	72.0%	67.8%	-4.2%
Royal Rehabilitation Centre	5.1%	6.8%	+1.7%
Prince Rashid Ben Al-Hasan Military Hospital	22.9%	25.4%	+2.5%

The distribution, share redistribution, and reallocation after the pandemic serve as evidence of the corresponding redistribution of surgical and critical care activity within the JRMS network. With the alleviation of the acute phase of the pandemic, the workloads were more evenly distributed between the regional centers (PRBMH) and specialized facilities (RRC). Such decentralization is a good sign of network resilience and the ability to recover to a more normalized and distributed model of operations.

CONCLUSION

The current study was able to utilize distribution data of the Rocuronium Bromide and Sugammadex vials, which were dispensed to three main JRMS hospitals, KHMC, RRC, and PRBMH, during the time frame 2020 to 2023, thus allowing the deduction of the significant trends in pharmaceutical logistics, consumption patterns, and clinical practice. The discussion adds to a considerable, yet temporary, impact of the COVID-19 pandemic on NMBA distribution in 2020, followed by a resolved and permanent shift towards more usage of the modern reversal agent, Sugammadex, with a specific dominance in the flagship hospital, King Hussein Medical.

The ratio of Rocuronium to Sugammadex was found to be an effective proxy to draw clinical preference. The wide range of variation, between 19.19 and 48.18 at PRBMH and RRC, respectively, stresses the point that NMBA reversal practice is highly heterogeneous throughout the JRMS network. KHMC can be observed as putting progressive efforts to lower this ratio, but the high value of the ratio at RRC means that it is an attempt to reduce costs at the expense of patient safety, and, therefore, it deserves more investigation to guarantee compliance with patient safety principles. Distribution-share analysis shows that a realignment of surgical activity is taking place as the proportion of total distribution volume in the post-pandemic period was moving towards the regional and specialized centers by 2023.

The results will provide the crucial empirical evidence to the JRMS Medical Supply Directorate to (i) optimize forecasting by taking 2020 as an outlier and use the 2022-2023 figures as a basis with an upward adjustment to Sugammadex adoption; (ii) standardize clinical practice by reviewing NMBA reversal protocols to assure equal patient safety and (iii) allocate resources to ensure a sustained investment in Sugammadex across all JRMS hospitals.

ACKNOWLEDGEMENT

Authors wish to acknowledge technical services rendered by Royal Medical Services, Jordan.

CONFLICT OF INTEREST

Authors of this article wish to declare that there is no potential conflict of interest.

REFERENCES

- Abad-Gurumeta, A., Ripollés-Melchor, J., Casans-Francés, R., Espinosa, A., Martínez-Hurtado, E., Fernández-Pérez, C., Ramírez, J., López-Timoneda, F., Calvo-Vecino, J., Group, E.A.R., 2015. A systematic review of sugammadex vs neostigmine for reversal of neuromuscular blockade. *Anaesth.*, 70(12): 1441-1452.
- Abu-Halaweh, S.A., Massad, I.M., Abu-Ali, H.M., Badran, I.Z., Barazangi, B.A., Ramsay, M.A., 2007. Rapid sequence induction and intubation with 1 mg/kg rocuronium bromide in cesarean section, comparison with suxamethonium. *Saudi Med. J.*, 28(9): 1393-1396.
- Almomani, A.a.M.A., 2024. Impact Of System Characteristics On The Usage Of Electronic Healthcare Records Among Jordanian Healthcare Professionals Performance.
- Awad, H., Al-Zu'bi, Z.b.M., Abdallah, A.B., 2016. A quantitative analysis of the causes of

- drug shortages in Jordan: a supply chain perspective. *Int. Bus. Res.*, 9(6): 53-63.
- Baccolini, V., Migliara, G., Isonne, C., Dorelli, B., Barone, L., Giannini, D., Marotta, D., Marte, M., Mazzalai, E., Alessandri, F., 2021. The impact of the COVID-19 pandemic on healthcare-associated infections in intensive care unit patients: a retrospective cohort study. *Antimicrob. Resist. Infect. Control.*, 10(1): 87.
- Brull, S.J., Murphy, G.S., 2010. Residual neuromuscular block: lessons unlearned. Part II: methods to reduce the risk of residual weakness. *Anesth. Analg.*, 111(1): 129-140.
- Iqbal, M.N., 2021a. COVID-19 Pandemic: SARS-CoV-2 Induces Immunologic Memory in Patients. *PSM Vet. Res.*, 6(3): 92-94.
- Iqbal, M.N., 2021b. COVID-19 Pandemic: The Omicron Variant and Natural Immunity. *Int. J. Mol. Microbiol.*, 4(3): 49-51.
- Iqbal, M.N., Ashraf, A., Shahzad, M.I., 2021. The Diagnostic and Therapeutic role of microRNAs in COVID-19 Disease. *Int. J. Nanotechnol. Allied Sci.*, 5(1): 1-6.
- JRMS, J.R.M.S., 2025. JRMS Official Website.
- Kim, Y.-S., Lim, B.-G., Won, Y.-J., Oh, S.-K., Oh, J.-S., Cho, S.-A., 2021. Efficacy and safety of sugammadex for the reversal of rocuronium-induced neuromuscular blockade in patients with end-stage renal disease: a systematic review and meta-analysis. *Med.*, 57(11): 1259.
- Krijtenburg, P., de Boer, A., Bash, L.D., Scheffer, G.J., Keijzer, C., Warlé, M.C., 2024. Trends in the use of neuromuscular blocking agents, reversal agents and neuromuscular transmission monitoring: a single-centre retrospective cohort study. *Perioper. Med.*, 13(1): 22.
- Naguib, M., Brull, S.J., 2009. Sugammadex: a novel selective relaxant binding agent. *Expert Rev. Clin. Pharmacol.*, 2(1): 37-53.
- Nassar, R.I., Thiab, S., Bashedi, I.A., 2023. The battle against COVID-19 in Jordan: A cross-sectional study assessing the experience of Jordanians who have been infected with COVID-19. *Pharm. Pract.*, 21(1): 2791.
- Palsen, S., Wu, A., Beutler, S.S., Gimlich, R., Yang, H.K., Urman, R.D., 2019. Investigation of intraoperative dosing patterns of neuromuscular blocking agents. *J. Clin. Monit. Comput.*, 33(3): 455-462.
- Soetikno, A.G., Lundberg, A.L., Ozer, E.A., Wu, S.A., Welch, S.B., Mason, M., Liu, Y., Havey, R.J., Murphy, R.L., Hawkins, C., 2024. Updated surveillance metrics and history of the COVID-19 pandemic (2020-2023) in the Middle East and North Africa: longitudinal trend analysis. *JMIR Public Health Surveill.*, 10: e53219.
- Szewczyk, M., Bieniecka, A., Sobolewski, K., Banasiak, Ł., Grabarczyk, Ł., 2025. Neuromuscular Blocking Agents and Reversal Agents Usage, and Neuromuscular Blockade Monitoring in the Intensive Care Unit—Review Article. *Int. J. Gen. Med.*, 3651-3688.
- Tamimi, A., Al-Abbadi, M., Tamimi, I., Juweid, M., Ahmad, M., Tamimi, F., 2024. The transformation of Jordan's healthcare system in an area of conflict. *BMC Health Serv. Res.*, 24(1): 1033.